

sive cloudlets, rather fracto-cumulus than true cumulus, formed over the smoke, none of them lasting more than three minutes, and most of them only one minute. Eight distinct cloudlets were seen thus to form and dissolve within the space of half an hour, at the end of which time the smoke had disappeared.

At Arequipa the wind, as stated above, was west 15 miles. Where the smoke was (14,000 feet) it was nearly calm. At the level of the cirro-cumulus clouds there was a strong current from west-northwest. Although the smoke column was small, evidently the conditions were favorable for cloud formation. The whole thing, however, was on a miniature scale.

Cumulus clouds over fires were described by Espy in his Fourth Meteorological Report. A recent case was noted by the writer in *Science*, January 8, 1897, pp. 60-61.

THUNDERSTORMS IN NEW BRUNSWICK, 1897.

By SAMUEL W. KAIN, Librarian of the Natural History Society of New Brunswick (dated St. John, April 4, 1898).

During the year 1897 I made some observations on the thunderstorms which occurred in this Province and perhaps the results may be of interest.

Before examining the record, however, it may be well to say a few words in a general way about thunderstorms.

Cause.—Russell says "thunderstorms are due to a rapid decrease of temperature with ascent in the air, and the presence of a great deal of moisture in the lower air."

The passage of a thunderstorm is so well known that it is hardly necessary for me to give a description.

In St. John the coming of a thunderstorm is preceded by cumulo-nimbus clouds appearing from the northwest during the afternoon or early in the evening. During 1897 thunder was recorded at St. John on the following dates:

Date.	A. M. or P. M.	Remarks.	Date.	A. M. or P. M.	Remarks.
May 21...	p. m.	Rainfall, 0.62.	Aug. 6...	p. m.	Distant.
June 16...	p. m.		Aug. 8...	p. m.	Slight.
June 18...	p. m.	Rainfall, 0.28.	Aug. 9...	p. m.	Distant.
June 20...	a. m.	Rain all day.	Aug. 15...	p. m.	Distant.
June 28...	p. m.		Aug. 17...	p. m.	Lightning; no thunder.
July 9...	p. m.	Distant.	Sept. 9...	p. m.	Rainfall, 0.36.
July 30...	a. m.	Rainfall, 0.57.	Sept. 10...	p. m.	Lightning; no thunder.
Aug. 1...	p. m.		Sept. 21...	a. m.	Rainfall, 0.48.
Aug. 4...	a. m.	Rainfall, 0.510.			

Of these storms 13 occurred in the afternoon and 4 in the morning. Two storms were reported from the Bay of Fundy, both at night. The storm of August 1 was the heaviest observed at St. John during the year.

Barometer.—The barometer falls on the approach of a storm. The highest barometer immediately before a storm was 30.06, on September 9; the lowest, 29.526, on June 28. On the arrival of the wind squall the barometer rises. On September 21 it rose from 29.6 to 29.64, or 0.04; on June 28 it rose from 29.526 to 29.586, or 0.06, and on June 16 it rose from 29.65 to 29.68, or 0.03. After the wind dies out the barometer falls and then rises gradually.

Temperature.—The temperature before these storms was in no case high. Prof. W. M. Davis, in his excellent book on meteorology, says that "the temperature preceding the storm is, as a rule, oppressively high." The highest temperature recorded just before a thunderstorm at St. John in 1897 was 70° F., on August 1. This was the heaviest storm of the year. The lowest temperature was 47° F., on May 1. The temperature preceding the storm of January 23, 1898, was only 18°.

When the wind squall arrives with rain the temperature falls slightly. During the storm of August 1, the thermometer fell from 70° to 67.3°, or 2.7°. In warmer climates the fall is sometimes from 10° to 20°.

Wind.—The wind before storms at St. John has, in nearly all cases, been shifting from southeast, southwest, and south, and then blows steadily from the northwest on arrival of the storm. All the storms came from the northwest except the great storm of August 1, which was from the northeast. It was a dead calm when this storm broke on the city.

The storms of August 8 and 15 were noticeable for the fact that while the heavy thunder clouds were rapidly advancing from the northwest the wind was blowing steadily from the southeast.

Rainfall.—The rainfall from some of these storms was heavy. On May 21 it was 0.62, on August 4 it was 0.510, on September 21 it was 0.48, and on August 1 it was 0.570.¹

During the storm of June 18 the heaviest clap of thunder was followed by hail. During the storm of August 6 hail fell at Loch Lomond, and Mr. C. H. Jackson tells me that the hailstones were large and rebounded as high as four feet from the platform in front of the Log Cabin Fishing Club. At Tower Hill and Oak Bay the hailstones did some damage to the crops.

No hail fell in St. John in the storm of August 9, but at Upper St. Davids, Charlotte County, large hailstones fell, breaking glass in the windows of a church, and on the same day at Meadows, Pomerey Ridge, Scotch Ridge, Tower Hill, Baillie, and Moores Mills, the hail did considerable damage to the crops. In some parts of Albert County on the same day the crops suffered considerable damage from hail.

Cloudburst.—The heavy downpour of rain known as a cloudburst is supposed to occur only in the distant west, but there can be no doubt that we had an exhibition of this unwelcome phenomenon in the great storm of August 1. It occurred near the premises of Mr. Edward L. Price, about 6 miles southwest of Sussex Station, about 3 o'clock in the afternoon. A correspondent tells me that the storm broke over the settlement with great violence. The lightning was intensely vivid, the thunder terrific, and the rain was indeed a cloudburst. The area affected was small, but great damage was done. The soil was scooped from the hillside, and a great scar, which can be seen at a considerable distance, remains as a lasting memorial of the visitation. The flood swept down the slope to the meadow lands and emptied into a water course known as the Burying Ground Brook, which leads to the cemetery at Upper Corner. Every farm bordering on the brook was injured. A number of small bridges were wrecked, a beautiful field with growing crop was destroyed by a landslide, a fine field of corn was covered with gravel and debris, and other standing crops were swept away. The damage was as follows:

Bridges and roads	\$400 00
Hay, oats, and other crops	2,000 00
Total	2,400 00

This estimate is based upon figures supplied by Messrs. G. H. Wallace, E. L. Price, and Frank Tufts, and if anything the loss is underestimated. The storm seemed to be confined to a narrow strip of land about 1 mile wide and 3 in length, stretching from McGinn settlement toward the Sussex cemetery. The greater part of the rain fell in ten minutes.

At Sussex there were thunder and the usual shower, but no indication that such a rainfall had occurred so close at hand.

Thunder was recorded in New Brunswick during 1897 on thirty-three days, divided among the months as follows:

March	1	September	3
May	3	October	0
June	8	November	2
July	7		
August	9	Total	33

¹This text and the date in the above table appear to be slightly discrepant.—En.

August leads closely, followed by June and July. Now, although thunder was recorded on this number of days, it must not be supposed that every record is a separate storm. Thunderstorms move at a rate of from 25 to 50 miles an hour, and the same storm may be recorded at Frederickton, Oromocto, Gagetown, St. John, and Point Lepreau. A careful analysis of the record leads me to the conclusion that there were 24 individual storms; and even of these at least one-half would be more properly termed thunder showers.

In this connection it may be mentioned that thunderstorms are of great frequency in equatorial regions, but are not so frequent in northern latitudes. In Java the average for a year is 97; in France, 29; in Finland, 2; in Iceland, 1.

In the rainless area of Peru no thunder is ever heard, while at Pueblo, in Mexico, in summer there is a thunderstorm every afternoon from 2 to 3 o'clock. (Russell.)

Thunder can be heard about 10 miles; lightning can be seen about 200 miles. Thunder and lightning have always been objects of fear, and a recent investigator found "that of 298 classes of objects of fear to which 1,707 persons confessed, thunder and lightning lead all the rest."

Lightning is a powerful destructive agent. Dr. Robert Bell, of the Geological Survey, considers lightning the commonest cause of forest fires, and supposes that such fires took place even in Pleistocene times. I am not aware, however, that this view is generally held. In our own time the destruction of life and property by this means is larger, perhaps, than is generally supposed. From 1880 to 1890 in the United States there were killed annually in this way 200 persons. In the eight years ending 1892 the fire losses due to lightning amounted to \$12,663,835. These figures are quoted by McAdie from the "Chronicle Fire Tables," and he considers them reliable.

I will now, as briefly as I can, present a statement of the damage done in this province during 1897.

Persons struck by lightning.—August 6, 2 p. m.—Joseph Wheaton, aged fourteen, killed in a hayfield at Middle Sackville. This was the only death from this cause during the year.

July 9, p. m.—Little girl disrobed and dress torn to tatters at St. George; not otherwise injured. She was playing on a swing, and the tree to which it was attached was shattered.

July 24.—Man knocked down and stunned by "ball lightning" at McAdam, but there were no serious results.

August 1.—A young man slightly burned on the neck and three other persons received slight shocks in a house which was struck in Carleton.

At Lepreau three young men were stunned and slightly burned. They were sitting in a room close to the telegraph office.

September 10.—A man living on the Buctouche road, near Richibucto, was struck on the head and severely cut. The current passed through a bench on which he was sitting and killed a dog and cat lying beneath.

Damage to property.—The damage to property by thunderstorms was considerable, as the following table will show:

	Loss.
Barns (15)	\$3,000
Dwellings (7)	450
Bridges and roads	400
General merchandise	100
Telegraph and telephone plant	250
Cattle killed	125
Horse killed	75
Hay, oats, etc. (in barns)	3,350
Standing crops	3,200
Total	10,950

The greatest destruction was caused by lightning where the stroke resulted in fire; rain did considerable damage, and

the hail which fell on August 6 and 9 also caused considerable loss to farmers. The following table shows the amount of damage caused by each of these agencies:

	Loss.
Lightning (where fire resulted)	\$6,950
Lightning (mechanical)	400
Rain	2,400
Hail	1,200
Total	10,950

From this statement it will be seen that the loss resulting from these storms fell nearly altogether upon our farmers. The losses were largely confined to barns and their contents.

This is what happens in other places, and it shows that a farmer will do well to keep his barns insured. Some insurance policies make no provision for loss by lightning; others pay losses when fire results from the lightning.

Any insurer can have a provision inserted, without extra charge, in his policy protecting the property insured, whether fire results from the lightning stroke or the damage is mechanical, and it would be wise for farmers to bear this in mind when making insurance contracts.

I wish to thank numerous correspondents for aid received in the preparation of this paper, and especially Mr. D. L. Hutchinson, to whom I am indebted for much information.

UPPER CLOUDS AND WEATHER CHANGES.

By GEORGE W. RICHARDS, Voluntary Observer (dated Mapleplain, Minn.).

Referring to the MONTHLY WEATHER REVIEW for May, 1897, page 212, I may say that I have made something of a study of the upper clouds in their relation to the weather of this section, and will mention a few of my resulting rules.¹

(A) During a cold snap, more especially during the winter season, near the close of a period of clear weather with northwest wind, if the northwest wind becomes very light or nearly calm, when the barometer has about reached its greatest height, either here or to the northward of us, with an area of cirrus and perhaps cirro-stratus covering the sky in the southwest, but moving toward the southeast or east-southeast in the morning, as in Fig. 1, Chart XII, for the first day, then the northwest or north wind will become nearly calm, and by the evening will turn to the northeast and perhaps east, and will, almost certainly, be followed by a moderate snowstorm that night or the next day with east to south-east winds.

By the evening of the first day, although the cirrus area is moving southeastward, the bank of clouds still has a tendency to lie farther northward, as will be seen in Fig. 2, and some of the wind will be in the northeast; but this is not the genuine northeast storm, and the snowfall is not nearly so heavy as in that. The wind (see Fig. 3) may be quite heavy from southeast during the night, and remain southeast the next morning. (See note at the end.)

(B) The genuine northeast storm is preceded by northeast wind with but slight change. Sometimes the cirrus with its haze covers the sky in the successive positions shown by Figs. 4, 5, 6.

If the cirrus area in the first afternoon has no more tendency to cover the clear sky to the northwestward than it had in the morning, as shown in Fig. 4, Chart XII, then the wind will most generally become more northerly and the storm has passed, or will pass, in a northeastward direction through Iowa, Wisconsin, etc., far to the east of the station. If later in the first day the cirrus haze, shown in Figs. 4 and 5, has a tendency to cover the clear sky to the northward of

¹ Mapleplain is located approximately in W. 93° 40', N. 45° 0', or 30 miles west-northwest of St. Paul.—Ed.